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OLIVE GROWING IN THE SOUTHWESTERN UNITED STATES

THE INTRODUCTION of olives into southern California took place 150 years ago, when the Franciscan Fathers made the first plantings near the San Diego Mission. Since then olive growing has become widely disseminated in many parts of California, in Arizona, and to a very limited extent in a few other sections, although it is only within the past 30 or 35 years that the olive industry has assumed a place of importance in the commercial fruit industry of the United States.

The olive can be grown successfully only in a comparatively mild climate. A temperature of 10° to 14° F. above zero is likely to prove disastrous to the tree, and the fruit will usually be injured by a drop below 28°. Furthermore, there are other limitations. Although the tree thrives fairly well in the humid regions of the South, where the temperature conditions are favorable, fruit production there is not sufficiently dependable to justify the planting of trees. The dry atmospheric conditions of California and the arid Southwest, where the temperature range is favorable and where irrigation supplies the necessary soil moisture, appear to meet the requirements of the olive.

Though few fruit trees withstand the limited soil moisture that the olive can endure, it likewise responds, as do other trees, to favorable soil conditions; in fact, it is only under such conditions that regularly successful results can be expected.

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OLIVE GROWING IN THE SOUTHWESTERN UNITED STATES

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OLIVE GROWING IN THE UNITED STATES

A CENTURY AND A HALF ago the Franciscan Fathers brought to this country some olives and planted them at the San Diego Mission, situated near the site of the present city of San

FIGURE 1.—Trees of the original planting of Mission olives at the San Diego Mission near San Diego, Calif. (Photographed in May.)

Diego, Calif. This first planting, whether in the form of cuttings, seeds, or otherwise, was the source of what is now known as the Mission variety. From here, during the next few years, the trees

were distributed to a number of missions in southern and central California. Some of the original trees, also those planted at the other missions, are still thrifty and productive (figs. 1 and 2). The olive was for many years the most prominent fruit in California; in fact, aside from the grape and the fig, which were introduced by the Mission Fathers about the same time as the olive and to each of which has been given the name "Mission", there were no other fruits of importance in California. On account of the sparse population, only small plantings of olives were made, and the culture of these was often neglected until nearly a century later, when interest in olive growing received a new impetus, and a few men planted good-sized orchards. From that time plantings have continued to increase, until today olive culture is a prominent factor in fruit production in California and is of some importance in Arizona. Statistics show that 503 olive trees were growing in California in 1855;[1] in 1876[2] there were 5,603 trees of bearing age; in 1901 the number was 539,568; and in 1929[3] there was an estimated total of 32,232 acres of olives in California, with 28,820 of them in bearing. In 1930[4] there were 136 acres[5] of olives in Arizona, of which 125 were in bearing. The production of olives in California[6] in 1931 was 16,000 tons. Production in Arizona was 99 tons[7] in 1930.

FIGURE 2.—A tree of the original planting at the San Fernando Mission, Calif. The tree as here shown was cut back several years ago to render the harvesting less expensive. The present top consists of sprouts from the stump. (Photographed in May.)

[1] On agricultural statistics of the State. Trans. Calif. State Agr. Soc. 1859, p. 343. 1860.
[2] Table of statistics . . . 1876, as reported to the surveyor general by the several county assessors, embracing the entire State. Trans. Calif. State Agr. Soc. 1876, p. 125. 1877.
[3] Calif. Crop Report, 1928, p. 53.
[4] Fifteenth Census Report, 1930.
[5] Number of trees divided by 70 to estimate the number of acres.
[6] Calif. Coop. Crop Reporting Service, Dec. 23, 1931.
[7] Fifteenth Census Report, 1930.

The importation of olives from foreign countries in the year 1929–30 amounted to 8,452,000 gallons; also 21,148,000 gallons of olive oil were imported.[8]

Until 1900 almost the entire production of olives in this country was utilized for oil, although for a number of years small quantities of green-olive pickles were made, and during a few years previous to this considerable interest was given to experiments in the processing of the ripe-olive pickles, the article which is now the basis of the olive-growing industry in this country.

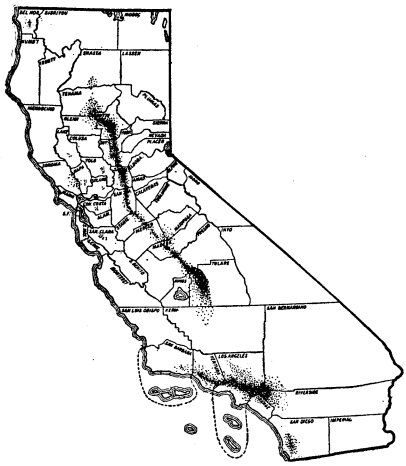

FIGURE 3.—Outline map of California, showing by means of dots the principal sections where olives are grown.

As there is a vast area of land suitable for olive culture lying within regions of congenial temperatures in California and Arizona, there is the possibility of a continued growth of this industry, the profitable marketing of the crop being the primary limiting factor.

Natural conditions have never given the olive industry any serious setback, but serious handicap has been experienced through the adulteration of the oil or the sale of other oil as olive oil, when the making of the latter was gaining rapidly in importance during the last years of the past century, and also through the faulty sterilization of ripe pickles, which more recently resulted in reducing the consumption of this commodity. Present California laws appear to obviate all dangers of faulty sterilization of packed olives.

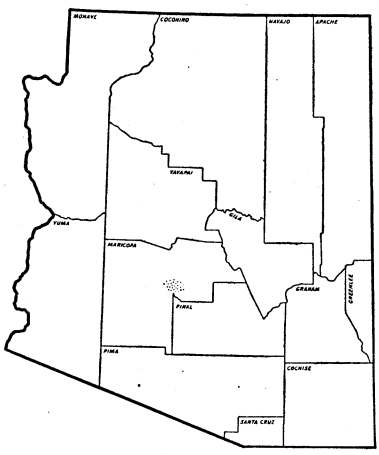

FIGURE 4.—Outline map of Arizona, showing by means of dots in the general vicinity of Phoenix the location of the principal olive-growing section in that State.

CULTURAL DISTRIBUTION

The region in which the olive may be successfully grown for the commercial production of fruit in the United States is not as great as that for most frost-hardy fruits and has been confined to portions of California and Arizona, although the trees will live and bear some fruit in portions of all of the southern tier of States of this country. Figures 3 and 4 show the regions in California and Arizona where olive growing is now a commercial industry. As with all other fruit crops in the comparatively warm, dry regions

[8] Yearbook of Agriculture, 1931, pp. 950, 965, 970.

of the southwestern part of the United States, the development of the olive industry has been, to a large degree, centered in a number of rather widely separated but extensive sections. Olives are found scattered throughout all the warm valleys where rainfall or irrigation is sufficient for the needs of the crop and where the range of temperature is favorable.

The olive is now grown commercially in at least 36 of the 58 counties of California (table 1) and in 2 counties of Arizona. The industry extends from near the border of Mexico to and including Shasta County, which lies next to the most northern county of California. This northern limit reaches nearly to latitude 41° N.

For convenience, the region of commercial olive production is here divided into five natural sections: (1) The Sacramento Valley, (2) the San Joaquin Valley, (3) the central California coast (the San Francisco Bay) section, (4) southern California, and (5) southwestern Arizona.

TABLE 1.—*Olive acreage in California in 1929,*[1] *by counties*

Section and county	Bearing	Nonbearing	Total	Section and county	Bearing	Nonbearing	Total
Sacramento Valley:	*Acres*	*Acres*	*Acres*	Central California coast (San Francisco Bay):	*Acres*	*Acres*	*Acres*
Butte	4,248	337	4,585	Sonoma	185		185
Sacramento	2,355		2,355	San Mateo	130	1	131
Tehama	1,450	636	2,086	Santa Clara	50		50
Shasta	75	1,250	1,325	Other counties	93	8	101
Yuba	890	142	1,032				
Glenn	606		606	Total	458	9	467
Placer	360	20	380				
Other counties	702	127	829	Southern California:			
				Los Angeles	1,365	1	1,366
Total	10,686	2,512	13,198	San Diego	1,300	8	1,308
				Riverside	1,205	5	1,210
San Joaquin Valley:				San Bernardino	1,165		1,165
Tulare	7,538	780	8,318	Ventura	412		412
Fresno	1,286	75	1,361	Santa Barbara	350		350
Kern	953		953	Imperial	59		59
San Joaquin	600	4	604	Orange	30		30
Madera	440		440				
Stanislaus	400		400	Total	5,886	14	5,900
Kings	250	10	260				
Merced	200	8	208	Total for State	28,820	3,412	32,232
Calaveras	123		123				
Total	11,790	877	12,667				

[1] California Crop Report, 1928, p. 53.

THE SACRAMENTO VALLEY

The olive is grown to a considerable extent through the low-lying foothill district along the east side of the Sacramento Valley, and scattered orchards may be found throughout the valley. The most important centers of production are near Oroville, in Butte County; at Fair Oaks, which lies northeast of the city of Sacramento, in Sacramento County; and at Corning, in Tehama County. More than 13,000 acres of olives are growing in the entire valley, of which over 10,000 acres are of bearing age. More than one third of the olive acreage of this valley is found near Oroville, which has become the largest olive-growing center in this country, because of favorable climatic and soil conditions. Little attention is given this crop in

the southwestern portion of the valley, which is swept by cool, moist winds throughout most of the summer.

THE SAN JOAQUIN VALLEY

The San Joaquin Valley joins the Sacramento Valley and lies to the south of it. Although the most extensive olive plantings have been made south of the center of the valley and along the eastern side of it, olive trees and orchards may be found scattered throughout much of the central and eastern parts of the valley (fig. 5). There are over 12,000 acres of olive orchards in this valley, of which over 11,000 acres are in bearing. Two thirds of the acreage in this valley is in Tulare County, Lindsay and Exeter being the principal centers. Along the west side and south end of this valley, olive growing is not a commercial industry, due to sparse rainfall and lack of provision

FIGURE 5.—An orchard of olives of the Mission variety near Lindsay in the San Joaquin Valley, Calif. (Photographed in August.)

for irrigation. The small nonbearing acreage (trees not of bearing age) in this and in the Sacramento Valley indicates the recession of interest taken in this crop during the past few years. The deep, heavy, fertile soils of several types—sandy loams and gravelly, dry adobe—which characterize the southeastern portion of the valley where olives are planted, are conducive to a more vigorous tree growth than are the conditions in localities farther north in this valley or in most places in the Sacramento Valley.

THE CENTRAL CALIFORNIA COAST (SAN FRANCISCO BAY) SECTION

Soon after olive culture had become a factor in fruit growing in California that portion of the State which includes the counties lying adjacent to or near San Francisco Bay was looked upon as offering promising conditions for its culture, but owing to the cool, moist sea breezes which prevail during the summer months over most of the section the returns have not warranted continued plant-

ing. Aside from the fruit not reaching a satisfactory size, the ravages of the black scale are general and severe. In some instances olive trees in this section have been removed to make way for the planting of more profitable crops. In places not swept by the cool winds and where climatic conditions are more like those of the interior valleys, the olive gives satisfactory returns. In 1929 there were less than 500 acres of olives growing in this locality, and practically the entire area was in bearing.

SOUTHERN CALIFORNIA

During the early years of the olive industry it was in the section comprising the southern third of California, from Santa Barbara County southward, that most of the olive trees were planted. The acreage in this fruit continued to increase until the past few years, although not as rapidly during very recent years as in the interior valleys farther north. In 1929, 5,886 acres were in bearing. The total planting was 5,900 acres. This is considerably less than the total planting in the San Joaquin Valley or in the Sacramento Valley. The counties in this section in which olive culture has reached greatest importance are Los Angeles, San Diego, Riverside, and San Bernardino, although orchards are found in all the warm valleys where irrigation water is available. As in the northern valleys, plantings are for the most part confined to the slightly elevated places through the valleys and on approaches to and over the low rolling foothills where irrigation water is available and where frost injury to the fruit is least common.

ARIZONA

Olives are grown commercially in only two counties of Arizona. The only important center of the industry (and therefore the only one considered here) is located near the city of Phoenix, Maricopa County. In this county the scattered orchards in 1930 (according to the Fifteenth Census report) totaled about 135 acres, of which approximately 123 were in bearing. Plantings in the remainder of the State aggregated less than 100 trees. Negligibly small numbers of trees were reported from Greenlee, Pima, Pinal, and Yuma Counties. The earlier plantings were made for the most part for oil production.

Both tree growth and fruit production in parts of this district where water for irrigation is available indicate that the soil is fertile and that natural conditions are satisfactory for olive culture (fig. 6). Climatic conditions here are similar to those of the principal olive-growing districts of the interior valleys of California, except that the summers are somewhat hotter and the annual rainfall less.

Conditions which appear to meet the requirements of olive culture are believed to exist in the Gila Valley in Yuma and Maricopa Counties and in the western half of Pinal County, and also in the Colorado Valley along the western border of Yuma County, though at present very few trees occur in these valleys.

In these sections, as in other olive-growing districts, there is danger of injury to the fruit by early freezes if the crop is excessive and therefore late in ripening or if the varieties planted are naturally late in maturing. The Mission and Manzanillo varieties are the

principal ones grown for pickling, while a few of the old orchards were planted for oil production.

CHOOSING A LOCALITY AND SITE FOR OLIVE PLANTING

In selecting a locality for establishing an olive orchard, the questions of most importance to be considered are for the most part the same as for other fruits. They include climatic conditions, the moisture requirements of the trees, soils, good roads, and the distance between the market or processing plant and the immediate orchard site.

LOCALITY FACTORS

CLIMATIC CONDITIONS

The most satisfactory climatic conditions for the olive are mild winters, where killing frost does not occur until late in the fall, and hot dry summers. A temperature below 28° F. will usually in-

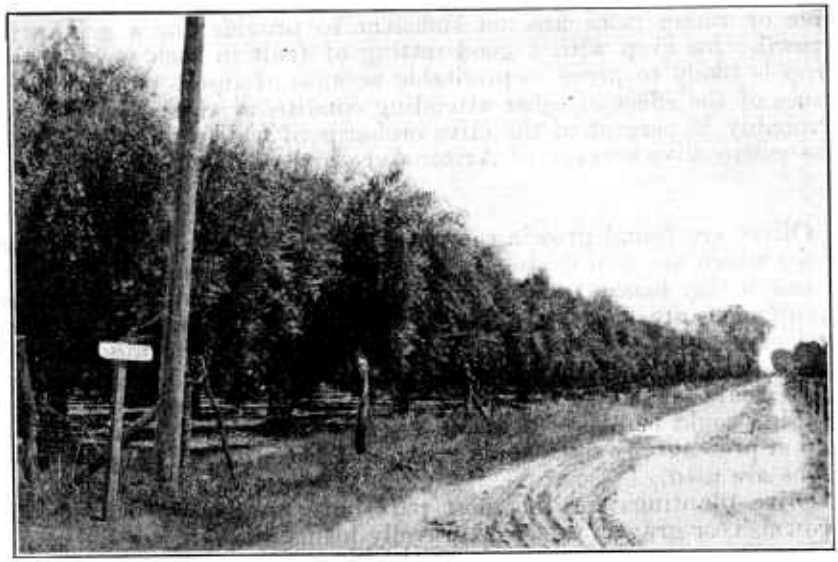

FIGURE 6.—An orchard of olives of the Manzanillo variety near Phoenix, Ariz. (Photographed in April.)

jure the fruit and 10° will prove detrimental to the trees. Cold, moist, or hot dry winds are not conducive to the setting or maturing of the fruit. Cold dry winds are especially damaging to the partially ripened fruit, causing it to shrivel. Such fruit can be used for oil only and is of second grade even for this purpose. If warm weather follows and there is sufficient moisture in the soil, the fruit will usually regain its natural plumpness. The olive does not blossom until after the danger of spring frosts is over, but it ripens its fruits very late in the fall when in most localities in the olive-growing regions of California and Arizona there is danger of injury to the fruit by light freezes.

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MOISTURE REQUIREMENTS

As it thrives best in a hot dry climate and the trees will live where protracted droughts are frequent, it was believed for some time after the olive was introduced into cultivation in the United States that irrigation was not necessary even where the close planting of the trees was practiced and where no intensive dry-farming systems were employed. This belief resulted in unprofitable returns from many orchards. At the present time it is recognized that, for satisfactory production, the olive is as dependent as are other fruits upon an adequate water supply. Owing to its requirements of a hot dry region where the black scale is not destructive and of an elevated site on rolling or sloping land for assurance against frost, irrigation is almost imperative for the regular production of abundant crops of large fruit. Dry rolling land where irrigation is necessary and water for it is available is therefore favorable, if not requisite, to the profitable production of olives for ripe pickles. For these reasons olives are not being planted to any extent for commercial orchards in localities where irrigation water is not available or where rains are not sufficient to provide for a good tree growth; for even with a good setting of fruit in such sections the crop is likely to prove unprofitable because of insect pests and because of the effect of other attending conditions which are adverse. Probably 85 percent of the olive orchards of California and almost the entire olive acreage of Arizona are under irrigation.

SOILS

Olives are found growing on many types of soil, but they prefer those which are well drained and fertile. Loams, sandy or gravelly loams or clay loams, which have not too high a percentage of humus or nitrogen are most satisfactory, although adobe land, if watered and given good surface cultivation to prevent the drying out and cracking of the surface, has given good results. The belief that the olive would make a good growth and produce profitable crops where nothing could be expected of other fruits has caused many failures, and at present only soils which are considered suitable for other fruit crops are used.

Olive plantings for the most part have been made on reddish, brownish, or grayish sandy or gravelly loams belonging to the residual or old valley-filling material groups, which are friable and well drained and darkened by a desirable quantity of humus. Although these types have proved to be satisfactory, their selection by olive planters resulted as much, probably, from a choice of climatic conditions as of soil, as they are the types on the lower rolling foothills, where the air drainage is good and detrimental frosts are not common during the ripening season.

Profitable orchards are found also scattered through the broad valley bottoms on fertile, well-drained, friable soil areas where sites of slight elevation are found, although the predominating soil type of these regions is characterized by a layer of heavy red-clay subsoil and of hardpan which prevents the penetration of tree roots and water.

Trees should not be planted where there is near the surface a stratum of hardpan or other material which is impervious to water.

In such places the tree grows very slowly and produces small crops, if any, and sometimes is affected with die-back or exanthema. Where trees have been planted in such soil, breaking up the subsoil by blasting if the stratum is beyond the reach of the subsoil plow, so that water may penetrate it readily, is considered advisable.

Where the stratum of heavy subsoil or hardpan is a few feet below the surface olive trees seem to do well if good culture is given, as they are naturally shallow rooted and do not require the depth of soil demanded by some trees.

Soils very rich in humus and nitrogen are inclined to result in excessive wood growth, in only moderate crops, and in delayed ripening of the fruit. This necessitates considerable pruning and expensive harvesting and involves occasional severe losses by the freezing of the fruit before it is ripe enough to harvest. Olive trees will live in soils where the humus and nitrogen content is very low, although in such places they usually make but little growth and bear unprofitable crops.

SITE FACTORS

Points of the most importance in the selection of an olive orchard site are (1) air currents, (2) soil drainage, (3) a contour suitable for irrigation, and (4), as with all other commercial fruits, areas where cultivation, harvesting, and marketing may be economically accomplished. As the fruit will be injured by freezing and will not ripen after it is harvested, the selection of a site free from low temperatures during the fall and early winter is of first importance. Low flat lands, the lower portions of ravines, and high flat tablelands should therefore be avoided; sloping stretches and rolling areas with the exception of the lower portions should be chosen, the elevation above sea level being of far less importance than the elevation above the valley or depression immediately adjoining (fig. 7). The air drainage in a depression of but a few feet below a frost-free area may be so poor that temperatures sufficiently low to render fruit unsuitable for pickling will occur. The same is true of the lower portions of ravines through which the heavy cold air flows to lower levels. Surface-water drainage is usually satisfactory where the slope is sufficient to insure air drainage, but care must be taken to avoid places where the subsoils are retentive of water. Places exposed to prevailing strong or dry winds should be avoided on account of the danger of damage to the blossoms, the very young fruit, or the fruit nearing maturity. On the other hand, moderate night breezes are desirable during the ripening season, on account of their tendency to prevent damaging frosts.

VARIETIES

The Mission variety, which is the one generally accepted as the best for planting in most sections of the United States where olive growing is an industry, was the first to be introduced. As it was for many years the only variety available, it was planted in most of our present olive-growing regions. During the last 30 or 40 years of the nineteenth century 80 or more varieties were introduced, mainly from Spain, Italy, and France, and grown in California. Most of this work was done in the southern portion of the State. Practically

all of these varieties were imported for the purpose of manufacturing oil. When the oil industry was displaced by the more profitable pickling of the large ripe olives, the demand for most of the small-fruited sorts which had been grown for their oil disappeared. As in the importation of varieties of other fruits, a large percentage of the varieties of olives proved to be unsuitable for commercial planting in this country, and most of them have been discarded. A few of these varieties, on account of ripening their fruit early in the fall or owing to their extra large size, are still being planted by those who are partial to these qualities. Only a few orchards of the oil-bearing olives remain, the others having been removed or grafted to large-fruited varieties.

FIGURE 7.—An olive orchard near El Cajon, Calif.

The most important varieties at present, aside from the Mission, are the Manzanillo, Sevillano, and Ascolano. A number of orchards have been top grafted during the past few years to the large-fruited variety Barouni, but because of difficulty in handling the fruit it is no longer favored. Most orchards of this variety are in the Oroville section of California. Plantings of a few others, including Nevadillo (*Nevadillo Blanco*), Redding (*Redding Picholine*), Columella, Rubra, Uvaria, Pendulina, and Oblonga, may still be found, but nurserymen claim that there is no demand for trees of these sorts for planting. The few really important varieties have been grown for a number of years under a wide range of conditions, and their performance in a locality has established their comparative merits and the advisability of their continued planting in that section.

MISSION

The Mission variety was disseminated from the Mission plantings in California, where it was grown from importations from Mexico

and is now the most important variety. It is grown in all important olive-growing sections. Its popularity results from the satisfactory growth of the tree and the production and high quality of its fruit for both ripe pickles and oil. The fruit is medium to large in size, although varying considerably in this respect, depending upon the size of the crop and the cultural conditions. The fruit is usually large if the crop is light or the cultural conditions good and is smaller when the crop is excessive or when unfavorable growing conditions prevail. In shape it is oblique-ovate, with a more or less decided point at the apex, deep purple in color, turning to a shiny jet black when fully ripe. The meat is firm and separates from the seed readily when pickled.

The Mission variety is superior for oil making, as well as for pickles. The tree is a vigorous, handsome, upright grower, suitable for borders, avenues, or windbreaks, as well as for general orchard planting. The strong tendency of the trees to make a vigorous upright growth rather than to spread requires that special attention be given to pruning where this variety is planted under conditions favorable for wood growth. The fruit ripens rather late, and injuries from fall freezes are so severe that earlier-ripening varieties are preferred in some sections. It is one of the most resistant of all varieties to the olive-knot disease.

In some orchards, or with individual trees, much of the fruit varies in form from the normal to a more regular broad-ovate, with but little indication of the point at the apex. These variations in the shape of fruit are peculiar to the Mission variety. They are considered by many to represent distinct strains, while some contend that these characteristics are the result of local environment. Both forms of olives may be found on the same tree and even on the same fruit stem, although the predominating shape of the fruit on a given tree is decidedly of one form or the other. An effort to establish by bud selection or otherwise a strain of this variety which will regularly produce the better broad-ovate type of fruit is highly desirable.

MANZANILLO

The Manzanillo variety was brought to this country from Spain and bears the Spanish name meaning "little apple", probably so because the rather broad depression at the base resembles the base of an apple. The fruit is a little larger than the Mission variety and ripens somewhat earlier. For this reason it is a suitable sort for planting in zones where ripe olives may be harvested before the occurrence of light freezes, which would injure the fruit of the later ripening Mission variety. For this reason and because of its regular bearing habits it is the principal variety grown in the olive-growing region of Tulare County, Calif., where olive production is an important industry. The fruit is not so firm as that of the Mission and therefore requires more careful handling when picking and processing it. It is also considered inferior to the Mission for oil making. The flavor of the ripe fruit when pickled is, however, of very high quality and is claimed by some to be unsurpassed. The fruit is of a regular rounded or broad-ovate shape and its color is a rich dark purple, changing to deep bluish black when fully ripe.

The tree is a vigorous grower and inclined to be broad and spreading, a shape which is always desired.

ASCOLANO

The Ascolano olive was brought from Italy. It is one of the largest fruited varieties grown in this country, being a little larger than the Sevillano. On account of its large size it has been used mainly for pickling. The fruit is very tender and requires special care in handling. It has a low oil content. When ripe it is a deep wine color rather than black. In shape it is a broad oval except for an inconspicuous point at the apex. Only scattered plantings of this variety remain.

SEVILLANO

The Sevillano variety is grown to some extent in a number of localities on account of its large fruit. In the Corning district of California it is grown almost to the exclusion of other varieties. It is claimed to be the large olive imported from Spain and known here as the "Queen." When properly grown its fruit is one of the largest produced in this country and is said to reach a greater size than when grown in Spain. It is of a rather long oblique-oval shape, resembling the Mission, is attractive as a green pickle, and makes a ripe pickle of fair quality, although if allowed to get ripe on the tree it is tender and easily bruised and so soft after processing that it must be harvested when not more than a thin blush of red is present in the skin. It is usually pickled when a yellow or straw color has developed and before a blush of red appears, and sometimes while green in color, even before signs of maturity are present.

The Sevillano is one of the most frost-tender varieties in common cultivation, so far as injury to the fruit is concerned. The tree is vigorous and is considered a good bearer. Like the Ascolano, its greatest point of recommendation for commercial planting is the large size of the fruit, although when pickled it is superior to the Ascolano both in flavor and texture. The oil content of the Sevillano is so low that it is not used for oil making.

The principal center of production of the Sevillano in California is in the Corning district, where over nine tenths of the total acreage, of about 2,000 acres, is in this variety. Numerous varieties were planted in this district, but the demand for large fruit and the satisfactory size of the fruit of this variety in this locality resulted in the top grafting of practically all of them to the Sevillano.

REDDING

The Redding (*Redding Picholine*) variety was introduced from France and widely planted for the production of oil under the mistaken belief that it was the true Picholine of that country (California Agricultural Experiment Station Report, 1898–1901, p. 271). It is still cultivated where the old orchards have not been grafted to other varieties or grubbed out, but no new plantings are made except to produce rootstocks for other varieties. The trees are vigorous growers and succeed under a wide range of conditions. It is an easy variety to graft. The fruit is very small, oval in shape, and

of a deep bluish black color when ripe. Though the variety is exceedingly prolific, the fruit is too small for pickling and is used entirely for oil.

NEVADILLO

The fruit of the Nevadillo (*Nevadillo Blanco*) variety is a little smaller than the Mission. Its shape is oval and regular except that it is somewhat blunt at both ends. When ripe it is a deep shiny black with a thin bloom. The ripe pickles are of good quality and flavor, and the fresh fruit returns a high quality of oil. It is too small to be considered first class for pickles. This is one of the first varieties to be injured by cold, and it is not being planted at present.

PROPAGATION

THE USE OF SEEDS AND CUTTINGS

The olive may be propagated by seeds and cuttings or by budding or grafting. As seedlings do not come true to the variety and therefore do not produce a uniform type of fruit, they are grown only for stocks on which to bud or graft. By far the greatest portion of the olive orchards in the southwestern United States have been grown from cuttings, and this method of propagation is still in use by most orchardists and nurserymen. The reasons given for preferring this method are that but little skill is required in making the cuttings and that the trees are more quickly and cheaply grown, at least to a size suitable for setting in the orchard, than budded trees. It is claimed by some that by budding or grafting a seedling stock, a tree superior to one grown from a cutting may be produced. The great number of orchards which have given satisfaction when trees grown from cuttings were planted allay the doubts of most planters, however, regarding the success of such trees.

For making cuttings, soft tender tips of branches or older hardwood are used. Nurserymen who require a large quantity of olive trees for their trade and propagate them by cuttings often use the branch tips, as it is difficult and expensive to secure hardwood cuttings of suitable size in sufficient number. They are also usually equipped with the necessary lath houses or other suitable means for furnishing the shade and protection from wind required by the young cuttings and for keeping in proper condition the beds of sand in which the cuttings are placed. About 4 inches is the usual length for making softwood cuttings. The tips selected should be those that have completed their length growth and are becoming firm but are not too hard. The condition of the growth, therefore, rather than any particular period of time, determines when the cuttings should be made. When preparing a cutting for planting the cut is made just below the node (the region where a leaf occurs), the same as for other plants. The two lower leaves are then removed and the others cut back about one half their length. The cuttings are then placed in the sand bed rather close together, where they remain until roots have started, which under favorable conditions is but a few weeks. They are then transplanted to nursery rows or beds, where they are left until they are ready for planting in the orchard. It is claimed

by some that trees thus grown have a better root system than those grown from large cuttings.

For making hardwood cuttings, branches three fourths of an inch to 1½ inches in diameter are usually chosen, although smaller or considerably larger ones may be used. Such cuttings are generally made 14 to 16 inches in length.

As with most other trees, the best time for making hardwood cuttings is when the wood is most dormant, which is during January and February. After the cuttings are made they are commonly tied in bundles, then placed in a trench, and covered with moist soil or other material to encourage callusing. When the soil becomes warm in the spring, they are placed a few inches apart in the nursery row, being planted 10 or 12 inches deep, so that only one or two buds project above the surface of the ground. Rooting takes place

FIGURE 8.—An olive orchard, originally of the Nevadillo variety, near San Fernando, Calif. The trees, as they appear here, consist of 6-year-old Ascolano grafts, the original trees having been top-worked to the latter variety. (Photographed in May.)

readily under favorable conditions. The sprouts which grow during the first season are allowed to remain during that season. Then the best one for developing a tree is selected, and all the others are cut off. Growth in the nursery row during the second season follows.

TOP GRAFTING

Top grafting is possible on olive trees of any age, and may be done at almost any time of the year with considerable success, although the best time to graft is just as growth starts in the spring. This method of changing an orchard from one variety to another was practiced in many cases in California during the transition period when the demand for fruit suitable for pickles was superseding that for the manufacture of oil and small-fruited varieties were replaced by large-fruited ones (fig. 8).

Both grafting into the stumps of large branches and budding into new shoots, which are allowed to grow for a year or so after the tree is cut back, are common practices (figs. 9 and 10). In preparing the tree for grafting, the limbs to be replaced by the new variety are cut off at any desired height by making a smooth, slightly slanting cut which will heal over quickly and not permit water to stand on the cut surface. The usual custom is to cut back only a portion of the top at one time, for fear of giving too great a shock to the tree, and the remaining branches are cut back the following year. If branches are to be left at the time those to be grafted are cut back, they should be selected so as to give as much shade as possible to the remainder of the tree. A coat of whitewash should be applied immediately to the trunk and stumps of branches to be grafted as a protection against sunburn.

FIGURE 9.—Olive scions 1 year old in a 30-year-old stump. (Photographed in May.)

The cutting back of the branches is usually done in late winter; and the grafting, when the trees start growth in the spring. As large wounds on the olive are inclined to heal over quickly and without leaving a permanent weak place in the branch at the point of grafting, larger branches may be removed than could be safely done with many kinds of fruit trees. This makes it possible to establish the new head low, which is always desirable with the olive, as the expense of harvesting the fruit is thereby lessened.

Where a large branch is removed, 2 or 3 scions are grafted in, spaced equally distant around the stump, to insure rapid healing over the stump and to furnish a more satisfactory number of branches for forming the new head than if one scion were used. This also insures to some extent against a total loss by the wind breaking the young branches.

Both cleft and bark grafting are practiced successfully. Scions of about one fourth of an inch in diameter and bearing 2 to 4 buds are considered most satisfactory. These should be placed so that the upper edge of the beveled surface of the scion fits firmly to the upper edge of the stump, and the union is tightly bound with cord or tape and protected from water with a coat of grafting wax. Support

FIGURE 10.—Scions that have made a growth of 3 seasons in an old olive tree near San Fernando, Calif. (Photographed in May.)

should be given the new growing branch to prevent it from being broken off by the wind. This may be done by placing a long stick beside the scion and tying it firmly to the old stump and the new branch.

TRANSPLANTING

As the olive is an evergreen tree and is grown in sections where only light freezes occur, transplanting may be successfully done at

almost any time of year, although the time accepted as the most satisfactory for transplanting this tree is after the soil has become thoroughly warmed in the spring, or during the period from about March

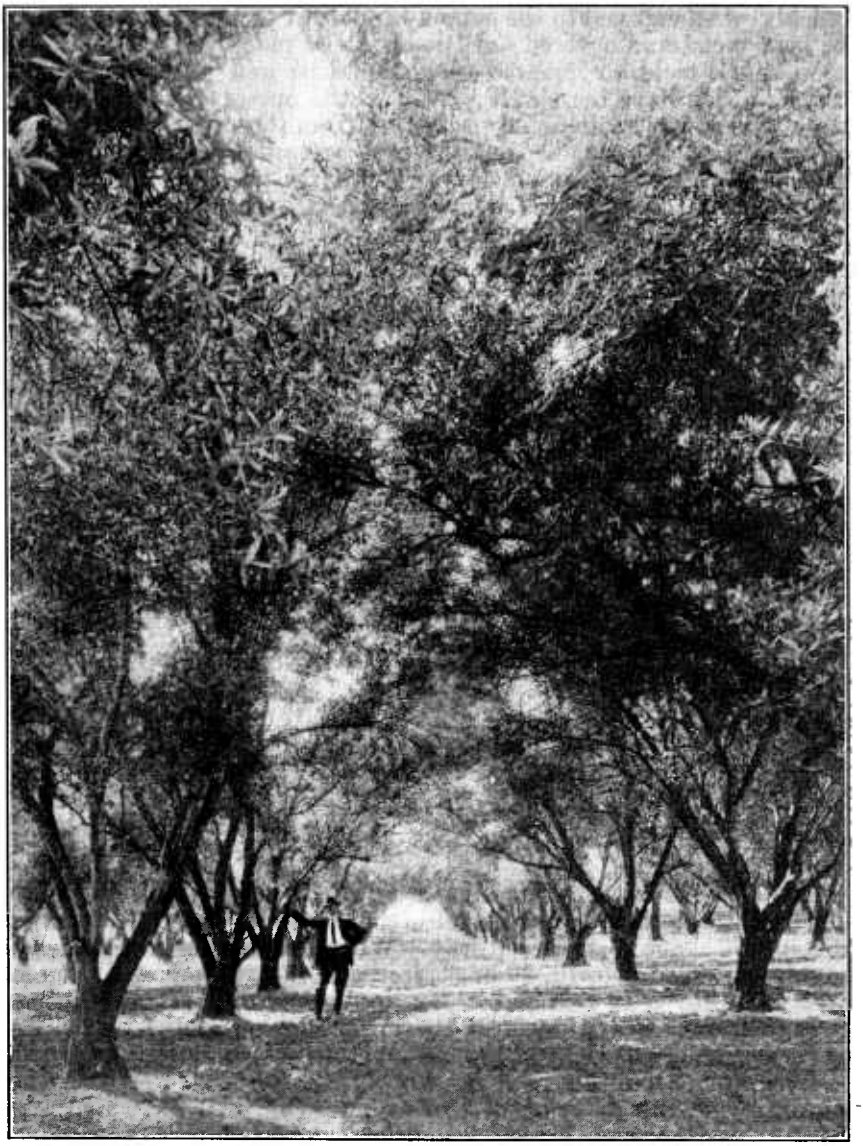

FIGURE 11.—Old olive trees of the Mission variety which were planted too close together. As a result the tops have become very high, thus making the harvesting of the fruit difficult and expensive. (Photographed in May.)

1 to May 15. If the earth is cold, the trees may fail to start growth for a considerable time, and some of the weaker ones may die. Only trees which have been well grown and have good root systems should

be planted. Good-sized holes should be made in soil that has been thoroughly prepared to a good depth and the tree placed a couple of inches deeper than it grew in the nursery. Well-pulverized moist earth should then be filled in around the roots. Olive roots dry out quickly when exposed to the sun or wind, so it is important that they be kept moist and covered until ready to be placed in the hole. As soon as the trees are planted they should be well watered, and the trunks which have been well shaded in the nursery by surrounding trees will now need artificial protection from the sun. A heavy coat of whitewash is valuable, but the tree protector manufactured for this purpose is more satisfactory. If thrifty trees are selected and the work of planting well done, the growth should start within a short time.

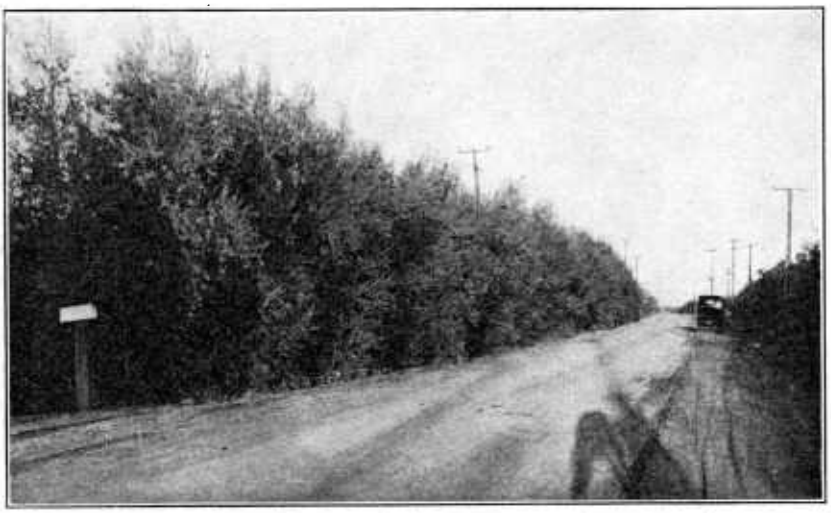

FIGURE 12.—A row of unpruned olive trees near Exeter, Calif., which serves as a windbreak and dust screen. (Photographed in March.)

PLANTING DISTANCE

The distance for planting olive trees varies considerably in different localities and with individual orchardists, although the common distance is about 25 feet each way. Where conditions are conducive to a heavy wood growth, 30 or 33 feet, and in extreme cases even 40 feet, has proved to be not too far, for where the branch and leaf growth is very heavy much of the lower portion of the tree is deprived of sufficient light if too close planting is practiced (fig. 11).

Where olive trees are used for windbreaks, 18 to 20 feet is a good distance (fig. 12). For borders or avenues (fig. 13), for which purposes they are very ornamental and under good culture are productive, the local conditions and the effect desired must determine the distance of planting.

Where too close planting has been practiced, growers have in some instances removed alternate trees with good effect, but planting an orchard with this end in mind is not desirable (fig. 14). The olive comes into profitable bearing rather late, especially on soils where

FIGURE 13.—A roadside planting of olive trees of the Mission variety near Phoenix, Ariz. (Photographed in April.)

FIGURE 14.—An olive orchard near Fontana, Calif., which was originally planted too close. This view shows the orchard 5 years after alternate rows of trees had been removed to relieve the crowded condition. The tree development and the production are now good. (Photographed in May.)

the tree makes a heavy wood growth, so when planted at normal distances one would secure only a few harvests before the trees would

FIGURE 15.—A 12-year-old olive tree of the Mission variety which at the time of transplanting was cut back to the height indicated by the stubs at the level of the man's hand. The tree as here shown has grown for eight seasons since it was transplanted.

have to be removed, and those remaining would have been crowded into an unsatisfactory upright growth.

The transplanting of large olive trees removed from orchards in order to increase the distance between trees has resulted in an excellent stand and a satisfactory growth of transplanted trees (figs. 15 and 16). This result has followed even where the limbs and roots of the removed trees have been cut back to short stumps (fig. 17).

INTERPLANTING

Interplanting olive trees with deciduous fruits, grapes, and annual crops is a common practice while the trees are young and where the soil is fertile and there is an abundance of water (fig. 18). Peaches, apricots, and plums are among the most satisfactory fruit trees for interplanting, as they come into heavy bearing early and will with-

FIGURE 16.—An olive orchard of the Mission variety near Strathmore, Calif. The trees were transplanted and are now 20 years old. (Photographed in March.)

stand heavy pruning and can therefore be retained for a number of years without causing an unsatisfactory development of the olive tree.

Annual crops may also be used, but the planting of them as well as of other fruits should be done with caution, so as to avoid undue competition for soil moisture and plant food between the olive trees and the interplanted crop. Interplantings should therefore be used only where moisture and plant food are plentiful, or, in case of an annual crop, where the planting is restricted to narrow strips between the olive rows (fig. 19).

CULTIVATION AND IRRIGATION

In the warm and dry regions, where most olive plantings have been made, cultivation is very necessary for keeping the land free from weeds. Since the soil in which olives are grown is, for the most part, loamy and friable, a satisfactory tilth is not difficult to maintain.

The system of cultivation generally followed in a commercial olive orchard is to plow once during the winter or early spring and give only shallow stirrings thereafter. The plowing should be at a moderate depth and finished a few weeks before the blossoms appear. Subsequent surface stirrings should then be given with a cultivator or disk harrow in order to destroy weeds which would rob

FIGURE 17.—An old stump of a Mission olive tree near Oroville, Calif., showing sprouts grown during 3 years since it was transplanted. (Photographed in April.)

the trees of the surface moisture. In this way the subsoil is well protected against drying out and the upper soil kept in good mechanical condition for new feeding roots, which will grow upward into it in the early spring.

While a high humus content is not desirable in the olive orchard, a moderate supply is needed to preserve a good physical condition of the soil for root growth and to maintain moisture. To secure this

it is the common practice to encourage a cover crop of wild vegetation during the winter or, occasionally, to sow in the fall one of the legumes commonly used for cover crops and allow it to grow until time for plowing in the spring. It is claimed that bitter

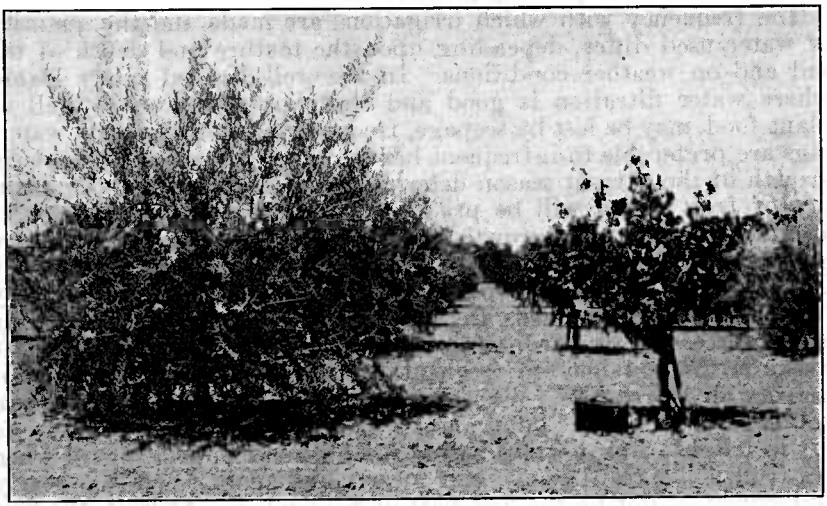

FIGURE 18.—A 5-year-old olive orchard of the Manzanillo variety interplanted with Sultanina (*Thompson Seedless*) grapevines, near Phoenix, Ariz. (Photographed in April.)

clover (*Melilotus indica*) and common vetch (*Vicia sativa*) have given the best satisfaction for this purpose. It is important that

FIGURE 19.—A catch crop in a young olive orchard of the Mission variety near Lindsay, Calif. (Photographed in August.)

this crop be not left in the spring until it has robbed the soil of too much moisture, as the period before blossoming is considered the most critical so far as setting a good crop of fruit is concerned. On the return of warm days in the spring, when evaporation of the

soil moisture is considerable, the combined effect of the roots of the cover crop and of the olive trees, the roots of which are inclined to be superficial, dries the surface soil quickly. This will result in difficulty in plowing, and the plowed soil will be left in a rough cloddy condition if plowing is delayed.

The frequency with which irrigations are made and the quantity of water used differ, depending upon the texture and depth of the soil and on weather conditions. In the well-drained sandy loams, where water filtration is good and considerable water, as well as plant food, may be lost by seepage, frequent light or moderate waterings are preferable to infrequent heavy ones. The vigor of the twig growth of the current season determines to a large degree the quantity of fruit which will be produced the next year, and a heavier and more thrifty twig growth results where frequent waterings are given rather than where the soil is soaked and later permitted to dry out. In the moderately deep and fairly well drained soils, where by far the most olive orchards are found, every 30 days is considered by many successful orchardists to be sufficient, but by some every 3 weeks is thought not too frequent for the economical watering of bearing olive orchards. Where water is scarce and applications can not be made at regular intervals it will be best (where possible to do so) to irrigate 2 or 3 weeks before the blossoms appear, again when the fruit is one third to one half grown, and again when it is nearly full grown, or during the first part of September. At least, the first and last of these irrigations should not be neglected, as they are considered to be the most critical periods with respect to both the current crop and the development of the tree for the following one. When fall and early winter rains are light, an irrigation should be given during this period, as the olive is an evergreen and therefore functions throughout the year. As evaporation is slow during the winter, one early irrigation will usually be sufficient for an entire dry winter if the soil is in good tilth.

As with other fruits, care must be taken that water drains out of the lower soil strata and also from all low areas; otherwise seepage water will collect in such places and cause serious injury to the roots. It is advisable, however, to leave unplanted the depressions where water and air drainage are faulty.

Irrigations that are too frequent or too heavy often prove detrimental where soils are underlain with hardpan or a stratum of poorly drained material which prevents the downward movement of water, as olive roots are sensitive to excessive moisture.

Olives are, as a rule, planted on friable soils where irrigation water moves downward rather rapidly and the feeding roots of the trees are inclined to be near the surface; hence, the use of a number of irrigation ditches between the rows, through which the water may be passed and the entire surface soil wet within a short time, is generally more satisfactory than where fewer ditches necessitate many hours for the percolation of the water through the soil (fig. 20). The use of only one or two ditches to the row often results in leaving broad areas with insufficient moisture between the rows, causing an excess of water to collect in low places and in subsoils which are naturally retentive of moisture.

FERTILIZATION

Most soils on which olives have been planted in the region under consideration are thought by many to be sufficiently supplied with plant food for satisfactory olive production Among olive growers, however, there is a general belief that fertilizers are needed, and the few who have consistently applied them over a term of years claim to have been well repaid with increased crops. The elements most needed, the quantity required, the time of application, etc., are, however, unsettled questions, as systematic tests to determine the need for the elements commonly used in fertilization have never been carried on or even undertaken in olive orchards in this country. Such tests would be of great value to the olive industry.

FIGURE 20.—A 7-year-old olive orchard of the Mission variety near Phoenix, Ariz., showing good growth; also showing the main irrigation ditch and the head ditch, with small outlets for the water into the orchard rows. (Photographed in April.)

PRUNING

The objects to be kept in mind in pruning the young trees are (1) to establish the form of tree which can be most conveniently cultivated; (2) to provide for a broad, low bearing surface from which fruit can be economically harvested; (3) to favor new growth on all parts of the tree and admit light for its development; (4) to remove interfering or cross branches; and (5) to maintain shade for the protection of the large limbs against sunburn. Although the growing of many varieties on a large number of soil types and over a broad range of climatic conditions has resulted in considerable divergence of opinion as to the most profitable methods to follow in pruning, pruners should keep the above ideals before them and let the severity of the pruning be determined by the needs of the individual tree.

Before the nursery tree is set in the orchard it should be headed back severely, leaving but 3 or 4 inches of each of the main branches.

It is well also to remove at this time all branches which will not be required for forming a desirably shaped tree. For the branches which are to form the top of the tree only strong upright ones should be selected, and these should be spaced a few inches apart along the trunk of the tree and distributed at distances as nearly equal as possible around it. When the tree as planted consists of a single stem it should be cut back to the point where one wishes the main branches to develop, which with most growers is 20 to 24 inches above the ground. Branching in many orchards has been encouraged at but a few inches above the crown, but this is not considered wise, as cultivation is made more difficult thereby. Before planting, the roots should also be shortened to a length permitting them to be placed in the hole without bending or twisting, and roots injured in digging should be removed at the point of injury. This will be about all the pruning necessary if the 4 or 5 main limbs branch as desired during the next few seasons, but in places where the upright growth of these limbs is very vigorous and they branch but little, they should be cut back during each of the next 2 or 3 winters to the point desired for the next branching.

For the method of pruning to be followed in succeeding seasons much will depend upon local conditions. On light or shallow soils, where wood growth is slow, little, if any, heading back would be done; severe cutting back will usually result in seriously stunting the growth of the tree. Pruning under these conditions should consist for the most part in the removal of interfering branches and in thinning out where small branches are too numerous to permit a thrifty development of new growth. This method will apply more especially to varieties which are naturally inclined to be low and spreading in their habits of growth.

In very fertile soil where the central or main branches make an excessive upright growth and are not inclined to form strong satisfactorily spaced lateral branches, the cutting back of these central branches each winter for a few years, to induce the growth of a greater number of framework branches, is desirable. In a few localities the conditions for wood growth are so favorable that the upright growth of a few main branches, which develop where little or no pruning is practiced after the first year, continues year after year at the expense of the lower lateral branches until within a few years the main portion of the crop must be harvested from tall ladders and at an excessive cost. Also, the shading of the interior part of the tree prevents growth there and leaves the main body but barren poles. The developing of a broad, low fruit-bearing surface by severely cutting back the rank interior branches for 2, 3, or 4 successive winters, to induce branching, has resulted successfully, although the trees have probably been delayed in coming into bearing.

Conditions are such that in by far the greater number of olive orchards the growth of the tree will come well between these two extremes of too little and of excessive upright growth, and each grower must decide as to the severity and regularity of pruning necessary to develop a strong, broad tree frame and maintain the other conditions already mentioned.

Where the growth of the young tree is so slow that no pruning is necessary to secure the open top and spreading shape, the crop

will usually be too light to be profitable, and orchard management along lines of cultivation, fertilization, irrigation, or drainage should be employed or adjusted to induce a more vigorous growth.

In all pruning of the bearing tree it must be remembered that the fruit is borne on the previous year's growth only, and the crop will be unsatisfactory if this wood does not make a thrifty, vigorous development. When no thinning out of small twigs has been practiced, thick brushes of slender drooping growth with but a very few inches of new wood often result. These masses should be thinned out to admit light to the remaining wood. This is more especially true where the tree is making poor or only fair growth. Where, owing to exceptionally favorable natural conditions or extra care, the trees are very thrifty and vigorous and are making considerable annual growth, the small branches do not droop to a very objectionable extent, the smallest, weakest twigs are crowded out, and little, if any, thinning is necessary.

The olive tree is naturally very long-lived and reaches a large size, and its period of profitable production should continue over many years. Therefore, the foundation branches should be so developed and the tree tops so kept within bounds by regular thinning that heavy crops may be borne and economically harvested.

Of the two principal varieties, the Mission and the Manzanillo, the former is much more inclined to make a tall, slender growth; it therefore requires considerably more attention at pruning time than the latter.

Trees in many orchards where conditions for wood growth are favorable have reached a height where the harvesting of the fruit is so expensive that the orchard cannot be maintained at a satisfactory profit, and heavy cutting back of the tree tops has been practiced to establish the bearing surface nearer the ground (fig. 2). Such pruning should be done with caution, as the production of the trees will be held back a few years by this practice. When the top branches are severely and uniformly cut back a very rapid upright growth of new branches will follow, and usually at the expense of fruit production. By removing some of the large branches and cutting others back to laterals, but not too severely, a more moderate growth of new wood is encouraged. This also develops the low branches by admitting light and secures a larger bearing surface. The latter practice is generally looked upon as the more satisfactory method of the two. The reheading of large thrifty trees should in all cases be followed by the frequent thinning of some of the vigorous upright-growing branches which follow the pruning and by the shortening of others, to keep the new head within bounds.

The open-headed tree, often termed goblet or vase shaped, is the form favored by some growers. This form is secured by cutting out all central branches after the main limbs have become well established and allowing a heavy growth of lateral branches to develop on the main branches, which grow from the tree trunk at an angle, but not permitting them to fill the center of the tree. While the yield of such trees will probably not be as heavy under all conditions as if some of the central branches were allowed to remain, the loss from the injury caused by the black scale will be far less, owing

to the admission of an abundance of noonday sunshine. In sections where this insect is troublesome this method of pruning is often practiced advantageously.

PROTECTION OF LARGE LIMBS FROM THE SUN

Where large branches are removed in pruning or cut back for top grafting, thereby exposing the bark of the remaining large branches to the sun, such exposed places should be immediately covered with a coat of whitewash to prevent sunburn. The new growth which will appear all along the branches within a short time will soon furnish sufficient shelter from the sun.

HARVESTING THE FRUIT

As a rule, the ripening season extends from 2 or 3 to several weeks, depending for the most part upon the size of the crop, but also upon the locality, the variety, and the use to which the fruit is to be put. Where the crop is light it may sometimes be harvested all at one time. In the foothill sections of the warm interior valleys of northern California fruit of the early ripening large-fruited varieties is sometimes ready for harvest in September if it is to be shipped East for pickling by the Sicilian process, and the harvest of varieties grown for ripe pickles usually starts early in October. In some sections near the coast, where it is cool and often cloudy during the summer months, the picking season is often not over until some time in February. Three or four pickings are usually necessary where the crop is heavy, especially if the orchard lies within the range of the cool sea breezes, where ripening of the fruit progresses slowly.

As it is preferable from the standpoint of the processor to gather all the fruit at the same stage of maturity, as there is usually fear of the fruit being injured by freezing, and also as the orchardist wishes to keep his laborers employed after the harvest opens, harvests are made whenever there is sufficient fruit to justify them. Where a number of pickings are necessary, the harvest becomes very expensive, as the fruit ripens unevenly on all parts of the tree and the entire tree must be gone over at each picking, and except where trees are small much of the fruit must be gathered from ladders.

To obtain a uniformly good quality of ripe pickles, well-matured fruit is necessary. The most practical guide for the picker is the color of the fruit. Some canners of ripe olives, whose product is looked upon by many as the standard of excellence, insist upon having only deeply colored fruit for processing. However, as the fruit on the lower, shaded portions of the tree does not color as rapidly as it does over the outside branches, no color standard for picking can be strictly adhered to, and the picker must be guided also by experience. With modern methods of pickling olives the dark color may be developed even if the fruit is immature, but immaturity is always betrayed by the quality of the product, as the meat, instead of separating easily from the pit and being smooth and of a rich flavor, is hard and brittle, adheres to the pit, and is lacking in richness. While immature fruit is not satisfactory for making ripe pickles, overripe fruit is also unsuited for this purpose, as it is soft and becomes bruised during picking and processing.

Some large-fruited varieties become very tender upon ripening and must be harvested before they are fully ripe, to avoid serious loss by bruising during picking and processing. They are not allowed to remain on the tree after the first blush of reddish color appears.

A maturity standard based on the oil content has been suggested as follows:

> A minimum oil content of 17 percent in the flesh is offered as a tentative standard of maturity for Mission olives and other common varieties except the Manzanillo, Ascolano, and Sevillano. A minimum oil content of 15 percent is recommended as a tentative standard for Manzanillo olives. No standards for maturity are recommended for the large-fruited olives, Ascolano and Sevillano, which must be gathered when relatively immature. These olives, however, should not be sold under the designation "ripe."
>
> Because of the great variations noted in the composition of olives of the same variety grown in different localities, it probably will never be practicable to set definite and hard-fixed minima for oil in mature olives, and the proposed standards must be applied with caution.[9]

For making ripe pickles, careful handling of the fruit during harvest has been recognized for many years as of first importance. Badly bruised or punctured fruit cannot be used for pickles and must be utilized for oil. The fruit is therefore gathered by hand and placed carefully in picking baskets or buckets and transferred to lug boxes for hauling to the pickling plant. Further to insure against bruises, some packers place some water in the picking buckets to serve as a cushion for the falling fruit. Stripping fruit from the branches with rakes and allowing it to fall on canvas spread under the tree is practiced occasionally by a few, but a low percentage of first-class products is expected from such methods.

While somewhat less care is taken in harvesting fruit which is to be utilized for oil making, it is recognized that only sound, well-matured fruit will render first-quality oil.

For making green pickles, which is a minor industry in this country, large fruits only are used, and these are gathered as soon as they are full sized or when a light-yellow color indicating approaching maturity appears, but before the pink blush develops in the skin.

When the processing plant may be reached in a day or so after picking, the fruit is shipped in lug boxes, but when several days are required for transportation, barrels are used and the fruit covered with salt water to prevent bruising and spoiling in transit.

GRADING AND PROCESSING THE FRUIT

When the fruit reaches the pickling plant it is first run through a sizing machine and separated into different sizes. During the pickling process each size is treated separately, as olives of uniform size can be pickled more uniformly than fruits of different sizes handled together, and the pickles are more attractive when sized. Fruit of different varieties is kept separate throughout the pickling process. This is necessary, not only for marketing but also because the fruit of different varieties is different in texture and quality.

Canners of olives do not have a uniform size standard into which they grade their fruit, although it appears that this would be very desirable. The difference in size between grades with most packers

[9] U.S. Dept. Agr. Bul. 803, A Chemical Study of the Ripening and Pickling of California Olives.

is one eighth of an inch in the narrowest diameter of the fruit. All small fruit, which is usually considered to be that below nine sixteenths of an inch in diameter, is utilized for oil; and the fruit above that size is graded into a number of sizes. Many types of machines devised for sizing olives are in use. Some have screens adapted for separating the fruit of different sizes; others have rollers spaced at the desired distances, over which the fruit is passed; while another type has diverging rollers, but all adjustable for delivering the fruit sized according to the required diameter. Handling the fruit in this operation must be carefully done, and the sizing machine, whatever the type, must be adjusted to prevent bruising the fruit.

From the sizer the fruit is conveyed to vats, where the pickling process starts. Wooden or concrete vats of many sizes are in use, although in the newer plants concrete vats are used almost exclu-

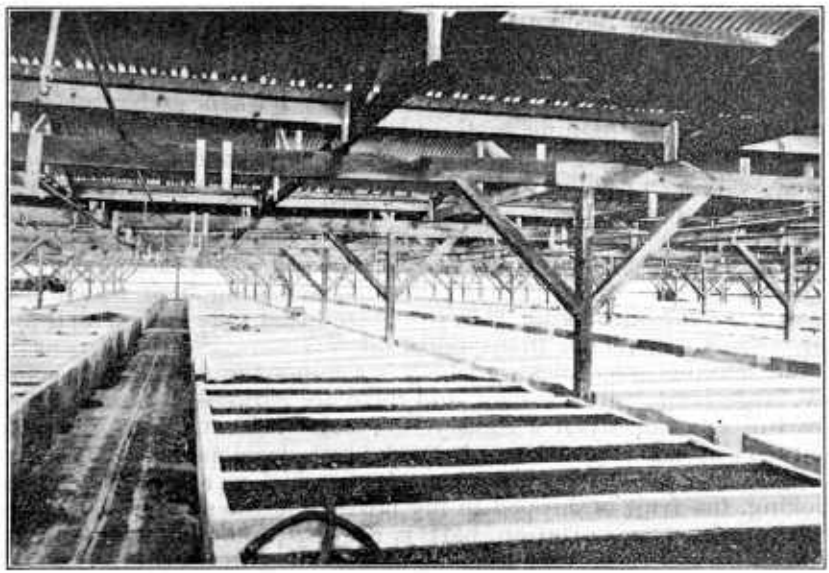

FIGURE 21.—An olive-pickling room, showing concrete processing vats.

sively (fig. 21). These vats are about 3 feet wide, 2 feet deep, and 8 to 9 feet long, a convenient size in which to give the fruit uniform treatment and to handle it easily with the least injury. Here the bitterness which is in the fruit when it comes from the tree is destroyed by soaking in a lye solution, and after the olives have been darkened by aeration and the lye removed by washing in fresh water the fruit is soaked for a few days in salt water. It is then removed from the vats, graded as to color, and canned with salt water after the bruised fruit is removed. The cans are now heated in a water bath or in retorts under pressure at a temperature somewhat above that of boiling water.

The California State Department of Public Health requires that all ripe olives, canned within the State, be held at a temperature of

240° F. for 60 minutes or 250° for 50 minutes to avoid all possibility of bacterial contamination. If packed in glass the requirement is the same.

Some variation of the above processing method, which has been in use since the pickling of ripe olives was first practiced in California, is employed by most olive canners. Though the details of the method, as outlined, are not carried out in the same way in all plants and though some claim secret variations or additions to the customary treatment, the fundamental principles of the commercial method are well known.

For the home preparation of ripe olives the following formula by M. A. Joslyn and W. V. Cruess, given in California Agricultural Extension Service Circular 37 (1929), should be adequate:

(*a*) The fruit: Use firm freshly picked olives ranging from the straw yellow to light pink stage of maturity. Black olives are too ripe and will usually give a soft pickled product. The Mission and Manzanillo varieties are best for the beginner; the Ascolano and Sevillano are very difficult to pickle successfully by the ripe process.

(*b*) Container: To hold the olives during pickling, use a stoneware crock (jar) or a wooden tub. A barrel cut in half makes two suitable pickling tubs.

(*c*) First lye: Prepare a lye solution (sodium hydroxide) containing about 2 ounces of ordinary flake or granular lye to each gallon of water. . . . A convenient method of preparing the solution is to note the contents of the can (usually 12 ounces) and add contents to the required amount of water. A household spring scale is useful for weighing lye, but is not necessary. When the lye is well dissolved in the required amount of water, add enough of the liquid to the olives to cover them well.

Stir once an hour, and occasionally cut several olives with a knife and note the penetration of the lye; as the lye enters the olive the flesh is turned to a yellowish color.

Allow the lye to remain until the skins of all the olives are well penetrated and the lye has entered the flesh to a depth of about $\frac{1}{32}$ inch or less. The time required varies with the temperature, the variety, and lye concentration. Usually 4 to 5 hours is required. The purpose of the first lye is to facilitate the darkening of the olives; if the lye penetrates too deep the color will fail to darken properly.

When the desired penetration has been attained remove and discard the lye solution.

(*d*) Darkening of color: Rinse the olives once with water, and discard the water. Leave them in the crock or tub exposed to the air to darken. Stir twice a day by covering with water and stirring in water. Discard the water each time. Let stand 4 days, stirring regularly as directed.

(*e*) Second lye: Prepare a new lye solution of 1 ounce of lye per gallon. Cover the olives with it and allow to penetrate about halfway to the pit. This will require about 3 or 4 hours. Remove the lye and discard it. This lye is also to facilitate the darkening.

(*f*) Second exposure: Rinse once in water and expose to the air for 24 hours, stirring occasionally during this exposure.

(*g*) Third lye: Prepare another lye solution of 1 ounce of lye per gallon. Place on the olives and allow to penetrate to the pit—about 4 to 6 hours is usually required. The purpose of this lye is to destroy the natural olive bitterness and must be allowed to completely reach the pit. This is judged by cutting several olives with a knife and noting depth of penetration. If the lye fails to reach the pits in 15 hours prepare and apply a fresh lye of ¾ ounce of lye per gallon until it reaches the pits.

(*h*) Third exposure: Rinse olives in water and expose 24 hours to still further darken the color.

(*i*) Washing: Then cover with water. Change the water twice a day for a week. The olives should now be free of taste of lye. Absence of lye or its presence in the olives is easily detected by taste; the amount present is harmless to the taster.

(*j*) Brining: Prepare a brine of about ¼ pound of salt per gallon (that is, 4 ounces per gallon or 1 pound to 4 gallons of water). Cover the olives with this brine for 2 days. They are then ready to serve.

(*k*) Storage: To keep the olives for several weeks replace after 1 week this brine with a fresh brine of 8 ounces of salt to the gallon of water (that is, 1 pound to 2 gallons of water). Store in this brine one week. Replace it with a fresh brine of 12 ounces of salt to the gallon (that is, 3 pounds of salt to 4 gallons of water). Change this brine once every three weeks until the olives are consumed, each time preparing a fresh brine of 3 pounds salt to 4 gallons of water (or ¾ pound to the gallon).

The olives will shrivel somewhat in this brine and are too salty to eat. Therefore, soak the olives in water overnight before serving. A weaker brine than the above is extremely dangerous, even if the olives are stored in open containers. Take no chances—use the brine as directed.

Ripe Olives Short Process.—If a dark color is not considered essential the olives can be pickled in a simpler manner than that given in the above recipe.

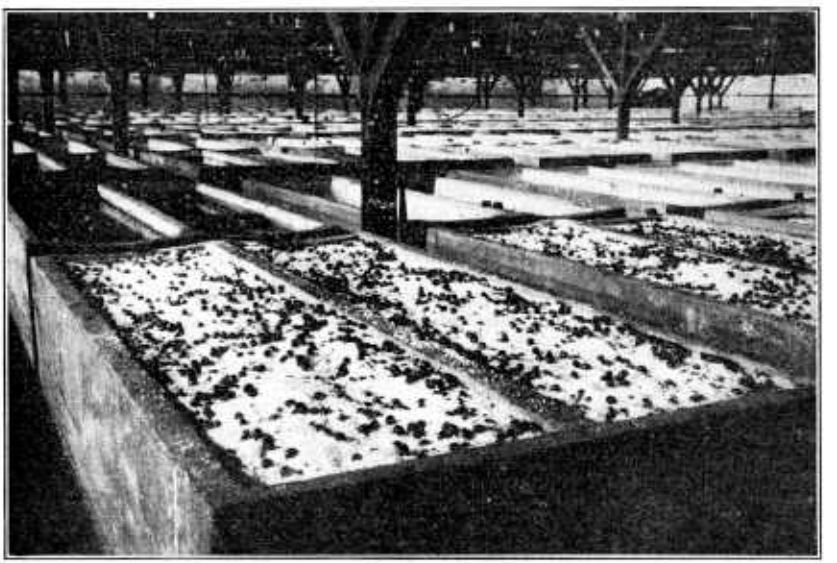

FIGURE 22.—Olives curing in salt in concrete vats.

Prepare a lye solution of 2½ ounces of lye per gallon. Place it on the olives and allow it to go completely to the pits; this will usually take 8 to 12 hours. Discard the lye. Cover olives with water. Change it three times a day until the olives are free from lye. Preserve in brine as directed in the first recipe.

The olives pickled in this way are usually of better flavor than those pickled by the first receipe, but are uneven and light in color, usually yellow to gray.

Ripe olives are cured also by soaking them in strong brine or mixing them with partly ground rock salt—processes in which no lye is used (fig. 22). In recent years a considerable quantity of olives has been treated in this way in California. For these processes only very well ripened fruit is used, and from 4 to 6 weeks are usually required to render the fruit palatable. The product, which is somewhat shriveled in appearance and acrid in taste, is prized by peoples from the Mediterranean countries. It has not been adopted to any extent as a food by Americans. Some fruit is prepared by what is called the Sicilian method, a process in which the fruit is cured with

salt and flavored with garlic, sweet anise, Spanish peppers, and sometimes other condiments. The product has a rich flavor, but it is not favored by most Americans.

Some fresh fruit, particularly of the early ripening large-fruited varieties, is sent east in boxes for processing or use in cooking by people from the Mediterranean countries.

Olives intended for green pickles must be taken from the tree earlier than those for ripe pickles and must not be aerated during the pickling process, as this would result in darkening the color of the fruit. Aside from these variations and a fermentation process to which the fruit is subjected to develop the flavor characteristic of green pickles, the method for making the green pickles is not different, except in a few respects, from that for making ripe pickles. The California ripe-olive standardization act of 1931 provides that the canned product shall be designated as seconds if there are more than 140 olives to the pound; if the fruit is not firm and reasonably free from woody, spotted, shriveled, misshapen, or otherwise defective olives, or has any foreign disagreeable flavor; if the fruit is not reasonably uniform in size and reasonably free from mixed varieties.

INSECTS AND DISEASES

Insect pests and diseases which cause serious loss in commercial olive orchards in the United States are few in comparison with those which attack most other cultivated fruits. Among the insects that attack the olive tree in this country the black scale is the only one of importance, and among the diseases the olive knot is the most destructive, although others of minor importance are more or less common.

INSECTS

Saissetia oleae Bern., or the black scale, as it is commonly known in olive-growing regions of the southwestern part of the United States, causes greater destruction to the olive in this country than any other insect and is responsible for seriously curtailing the output of fruit in some localities. It does not confine its attacks to the olive, but feeds on a great number of both deciduous and evergreen plants which are widely distributed, making it exceedingly difficult to eradicate, and it must therefore be considered when olive plantings are contemplated. Fortunately, it does not thrive in sections where the summers are hot and dry, such as is the case in practically all of the olive-growing sections which are not cooled and moistened by sea breezes, and in such places spraying is seldom necessary for its control. In the damper regions along the coast, however, the black scale and the black smut which accompanies it cause serious loss where preventive measures are not used.

DISEASES

KNOT (BACTERIUM SAVASTANOI)

The disease which has caused the most serious loss in olive orchards is the olive knot (fig. 23), which is produced by a bacterium (*Bacterium savastanoi*). This bacterium attacks all parts of the

tree, including the leaf and fruit stems, but is most harmful on small growing twigs and young vigorous trees. Its destructiveness is most marked in localities where it is warm and moist and conditions are favorable for a rapid tree growth. The best preventive measure known is cutting out the infected portions and disinfecting the resulting cuts, much as is done in pear blight. As the bacteria come from the knots and are carried to other parts of the tree in wet weather only, their spread may be best prevented by pruning out infected branches before the winter rains occur.

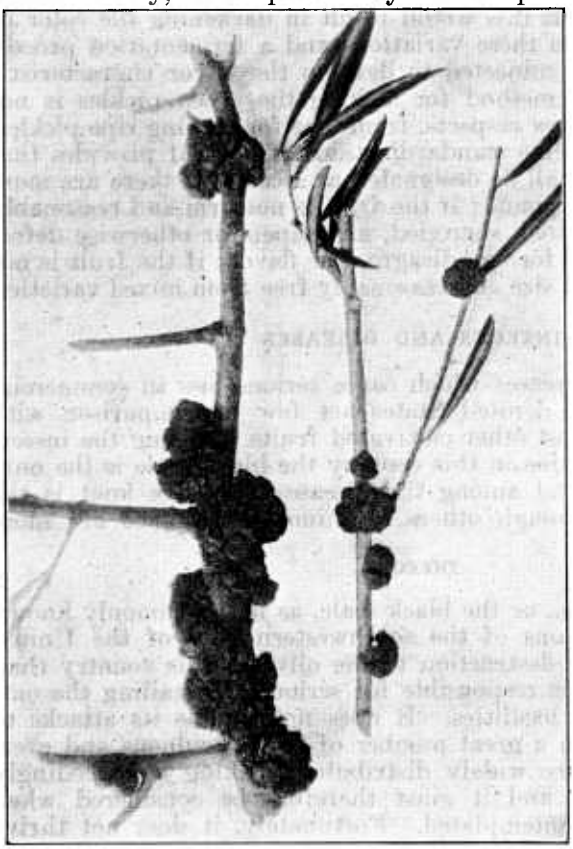

FIGURE 23.—Branches of the Nevadillo olive, showing olive knots. (Photographed in June.)

The variety most seriously damaged by this disease is the Manzanillo, although the knot is common on a number of the small-fruited varieties grown for their oil. It is not, as a rule, a serious menace to the Mission, Ascolano, Sevillano, and other large-fruited varieties, the Mission being almost immune to it.

DIE-BACK, OR EXANTHEMA [10]

The die-back of olive trees, which has recently come into more or less prominence in a number of localities, causes the dying back of the twigs and branches. The growing tips of leading branches usually die first, and new growth starts from nodes below, and these, in turn, become stunted and die (fig. 24). Affected trees fail to bear fruit, and loss of a large portion of the tree, if not the entire tree, follows within a few years. The trouble is most common where subsoil drainage is faulty. Blasting, subsoiling, or otherwise opening the subsoil to permit a free circulation of moisture and air through it is thought to be the most practicable remedy.

[10] Diseases of the Olive. In Pac. Rural Press, v. 88, no. 3, p. 54, 1914. Some Diseases of the Olive in California. In Olive Jour. v. 1, no. 9, p. 4, 1917.

DRY-ROT [11]

Attacks of dry-rot result in the shriveling and browning of spots in the flesh of the fruit, and in some seasons it causes considerable trouble. The diseased spots take lye during the pickling process more readily than the surrounding healthy tissue, and great care must be taken during processing if the affected fruit is to be used for ripe pickles. A soft rot that attacks the fruit, the apex of the fruit most commonly, sometimes does considerable damage. Fruit affected with it cannot be used for processing. Loss from this cause is more severe

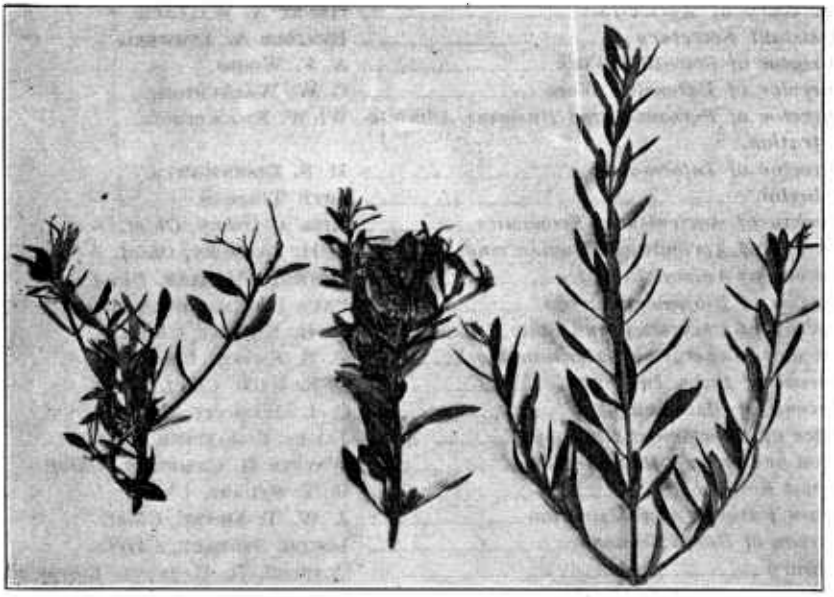

FIGURE 24.—Olive twigs affected with die-back (at the left). The branch at the right is in a normal healthy condition.

in the large-fruited varieties and more destructive some years than others. As this trouble does not appear until the fruit starts to ripen, some loss is averted by harvesting it early.

Olive growers should be constantly on the lookout for destructive insect pests and diseases which cause preventable loss either to the tree or fruit. Both insect and disease problems should be referred without delay to either a State agricultural experiment station or to the United States Department of Agriculture for advice. The timely use of preventive or control measures may prevent serious loss.

[11] Olive Journal, v. 1, no. 5, p. 7, 1916.

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